

Fijian Cannibalism: Osteological Evidence From Navatu

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ABSTRACT The hypothesis that the human remains from the Navatu midden (50 BC to AD 1900) in Fiji represent cannibalized individuals was tested by an analysis of the skeletal remains. The site includes formal human burials and a separate, contemporaneous midden containing commingled fragmentary human and nonhuman bones. All remains were examined for a variety of modifications. The medium mammal and human remains in the midden have similar modifications: ancient breaks (92% of midden human specimens and 88% of medium mammal specimens), burning (29% and 11%), crushing (1% and 1%), cutmarks (9% and 8%), peeling (4% and 1%), and percussion pits (1% and 1%). The human burials (for which cannibalism had not been hypothesized) are essentially unmodified except for some breakage. The pattern of element representation and low incidence of animal bitemarks rules out carnivores and rodents as major modifiers of the assemblage. The breakage patterns, element representation, light weathering, and rarity of random striae indicate that sediment pressure, wave action, weathering, and trampling did not significantly alter the remains. The modifications of the midden human and nonhuman remains generally correspond in type and frequency. The evaluation of the assemblage's taphonomic history suggests that most of the modifications were caused by humans. The Navatu midden human sample does not resemble assemblages interpreted as secondary burials with defleshing, nor does it resemble violence-derived assemblages. The burials at Navatu and other Fijian sites indicate that the various noncannibalistic Fijian mortuary rituals do not mimic butchery and consumption. Therefore, the hypothesis of cannibalism at Navatu is supported. *Am J Phys Anthropol* 110:215–241, 1999. © 1999 Wiley-Liss, Inc.

Cannibalism is one of the most contentious topics in anthropology (Osborne, 1997). The fundamental question of whether cannibalism was ever a customary practice in any culture remains a matter of debate (Arens, 1979; Bahn, 1992a; Osborne, 1997; Sahlins, 1983). There are many historical reports of cannibalism, but their accuracy has been challenged (Kolata, 1986). Arens (1979), for example, dismisses these reports as unreliable products of biased missionaries and explorers, and argues that there is no good record of customary cannibalism in any cul-

ture. Other anthropologists accept at least a portion of the ethnohistorical record of cannibalism (e.g., Sahlins, 1983). Some archaeological skeletal assemblages have been interpreted as the remains of cannibalistic activity (e.g., Turner, 1989; White, 1992), but these inferences have been questioned (e.g., Bahn, 1992b; Bullock, 1991; Darling, 1998).

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The most detailed bioarchaeological work on cannibalism has been done on skeletal collections from the American Southwest (Turner and Turner, 1999; White, 1992). Some of the strongest ethnohistorical evidence for cannibalism, though, comes from the South Pacific, particularly Fiji (Rechtman, 1992; Sahlins, 1979, 1983; White, 1992). Sahlins (1979, 1983) and Rechtman (1992) argue that the abundant historical record of Fijian cannibalism is accurate and that it refutes the claims of Arens (1979). The question of Fijian cannibalism has centered on the reliability of written accounts but, as Moctezuma (1987) noted, hypotheses derived from the ethnohistorical record can be tested by archaeological excavation and analysis.

The hypothesis that an archaeological assemblage represents the remains of cannibalistic activity can be tested using the methods of White (1992). In summary, the approach is to first quantify the modifications (cutmarks, burning, etc.) of the skeletal remains. Then the modifications of the human remains are compared with those of related nonhuman faunal assemblages interpreted as dietary debris. If the modifications are similar in both the human and nonhuman samples (allowing for differences in anatomy), then an inference of cannibalism is warranted. Additionally, the taphonomic history of the assemblage must be assessed, and an evaluation made of the possibility of noncannibalistic mortuary rituals that might mimic butchery and consumption.

Analysis of the archaeological record has so far failed to test the ethnohistorically generated hypothesis that cannibalism was a customary practice in pre-colonial Fiji. Gifford excavated two sites on the Fijian island of Viti Levu and found burnt and broken human bones mixed with the remains of other animals (Gifford, 1951). He concluded that, "Except for fish, man was the most popular of the vertebrate animals used for food," (Gifford, 1951, p. 208), but did not present any data or analysis to support this inference. Best (1985) observed charring and cutmarks on some of the human bones he recovered from Lakeba, and concluded they were cannibalized, but provided no data on those or any other modifications.

Spennemann (1987) cataloged the cutmarks to the human bones from a tree-fork "cannibal" trophy on Viti Levu, but his sample was limited to 13 relatively intact human bones.

The most extensive archaeological work on Fijian cannibalism to date is that of Rechtman (1992), who reported 1.2 kg of "cannibalized" human bone from his excavations on Wakaya. The sample size is given only in terms of weight, with no indication of the number of identified specimens. Cutmarks and burning are noted as rare (Rechtman, 1992). Two attributes (fracture angle and fracture outline) were scored for the human long bone fragment assemblage, but only relative frequencies are reported (Rechtman, 1992).

White's 1992 assessment of the study of cannibalism in the Oceanic archaeological record remains accurate:

"Across the Pacific archaeologists have worked in contexts where ethnohistorical accounts predict cannibalism. Fragmentary human bone has often been found in midden contexts and interpreted to represent cannibalism. The latter activity has never really been questioned by archaeologists. Therefore, the primary analysis of the human remains has been at an understandably superficial level . . ." (White, 1992, pp. 21–22).

The possible existence of cannibalism in pre-colonial Fiji is examined here by a detailed study of the skeletal material recovered from the site of Navatu by Gifford (1951). Gifford (1951) hypothesized that the human remains found in the Navatu midden represented cannibalism. This hypothesis is tested here by comparing the modifications seen in the midden-derived human remains with those of the other midden fauna and with the alterations in the contemporaneous human burials from the same site. The existence of cannibalism in pre-colonial Fiji is supported by the analysis of this portion of the archaeological record.

MATERIALS

The sample studied was excavated by E.W. Gifford in 1947 at the site of Navatu (Fig. 1) on the island of Viti Levu (18° S, 178° E; 10,388 km²) in the Fijian archipelago. The deposits span the period from 50 BC to

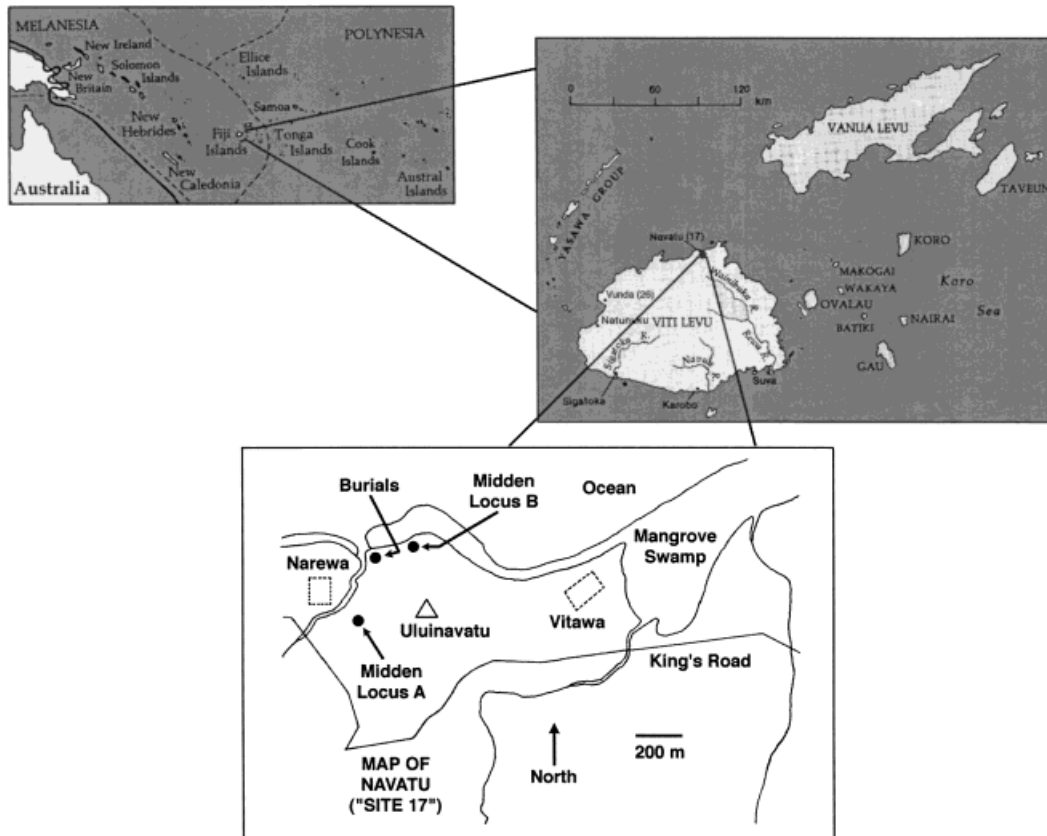


Fig. 1. Map of Navatu (site 17) redrawn from Gifford (1951). Narewa and Vitawa were extant settlements in 1951. Uluinavatu is a rock formation with a peak height of 632 ft above sea level.

AD 1900, and are divided into three general time periods by pottery styles and radiocarbon dates (Gifford, 1951, 1955; Green, 1963). The Early Period is from 50–100 BC to AD 800–1100, the Middle Period is from then to AD 1600–1800, and the Late Period is from then until circa AD 1900. There is no evidence of the earlier Lapita culture at Navatu (Green, 1963). The separation between the time periods is not precise, as Gifford excavated in 6-inch intervals, some of which may span two periods.

A waste midden at the site was excavated at two loci, referred to as 17A and 17B. The midden was composed of a mix of shell, potsherds, and bone fragments of many taxa, including humans. The bone fragments of all taxa, including humans, were commingled, and the spatial patterning of the human remains within the midden appears

random. Several Late Period burials were recovered outside the boundaries of the midden at a third locus (Fig. 1). The burials are spatially and contextually distinct from the midden, as the burials contain only relatively intact human bones and a few potsherds. The burials are of Fijians based on the associated artifacts and the non-metric traits of the skeletons. Gifford (1951) concluded that all three loci were from one occupation site based on their close proximity (within 400 m) as well as the results of his surface survey and test trenching.

Gifford excavated the midden in a series of 3×6 ft rectangles, excavating in arbitrary six inch increments. Eleven of these rectangles were excavated at 17A, and one at 17B (Table 1). A description of the features found is given in Gifford (1951). Gifford did not state the exact recovery method used in

TABLE 1. Depth in inches of time periods by excavation rectangle, with radiocarbon dates

Locus; rectangle	Depth (in.) of			Radiocarbon sample depth and date
	Late period	Middle period	Early period	
17A; A3-4, B3-4	0-18	18-30	30-48	
17A; B3-4, D3-4	0-12	12-30	30-84	
17A; D3-4, E3-4	0-12	12-24	24-96	
17A; E3-4, F3-4	0-24	24-42	42-120	104"; 2,000 ± 500 b.p.
17A; H3-4, I3-4	0-30	30-60	60-84	
17A; I3-4, J3-4	0-24	24-48	48-78	
17A; N3-4, O3-4	0-30	30-42	42-60	
17A; R3-4, T3-4	0-24	24-30	—	
17A; T3-4, U3-4	0-30	30-36	—	
17A; S4-5, T4-5	0-24	24-36	—	
17A; T4-5, U4-5	0-18	18-30	30-36	30"; 950 ± 300 b.p.
17B; A1-1.5, C1-1.5	—	0-84	84-144	90"; 1,200 ± 500 b.p. 96"; 1,300 ± 500 b.p.

the excavations, but screening was employed, and he noted that all bone was saved (Gifford, 1951). Very small bone fragments (longest dimension <1 cm) were recovered, so there was probably no significant size bias introduced by the excavation methods.

The human remains from this site are divided into two analytical categories: the midden human sample (the human remains from the two midden loci; Fig. 1) and the burial sample (the human remains from the formal burial locus; Fig. 1). The midden human remains are further divided into two subcategories: those from midden locus 17A, and those from midden locus 17B. All nonhuman fauna is from the midden and is similarly divided by locus (17A and 17B).

The numerical majority of bones in the midden are of fish. Due to time constraints, a randomly selected portion of the fish remains was analyzed rather than the entire fish sample. All remains labeled by Gifford and co-workers as "fish" were inspected to confirm that taxonomic identification. Every recovered nonfish bone was analyzed.

The faunal composition of the midden is given in Table 2. The nonhuman mamma-

lian fauna consists mostly of pig (*Sus scrofa*), with some dog (*Canis familiaris*), bat (*Pteropus* sp.), rat (*Rattus exulans* and *Rattus norvegicus*) and, at the upper-most levels, goat (*Capra hircus*) and cattle (*Bos taurus*). For analytical purposes, the rat and bat remains are grouped as "Small Mammal," while the other nonhuman mammals are grouped as "Medium Mammal." The reptilian fauna is entirely turtle (*Chelonia* cf. *mydas*), while the avifauna contains representatives of Phasianidae, Falconidae, Rallidae, Anatidae, and Charadriiformes/Procellariiformes (T. Stidham, personal communication). The fish taxa are given in Fowler (1955). There are a number of small fragments of limb shaft (longest dimension <2 cm) which are not identified beyond class Mammalia. They are termed "Mammal CBH (Could Be Human)" and are not counted toward either the human or nonhuman totals. The "Indeterminate" category contains specimens that are not human, but were not identified beyond that. The human burial sample is composed of 582 human specimens.

The minimum number of individuals (MNI) in the midden human sample is given in Table 3, along with the maximum number of individuals and the number of identified specimens of each element. The MNI values take into account antimeric correspondence, age category (immature or adult), and, for dental elements, the general degree of occlusal wear. The total MNI for each element was figured by taking the sum of the MNIs of each time period for that element, on the assumption that no single individual occupied more than one time period. It is possible that a single individual spanned both midden loci in a given time period, so the total MNI values for an element reflect an MNI analysis of the pooled 17A/17B sample for each time period. The MNI analysis was performed while the midden human sample was conjoined (see below). The MNI values for the midden human sample are influenced by the high degree of fragmentation, and so are not comparable with more intact assemblages.

The overall MNI in the midden human sample is seven, based on temporal fragments. This includes at least two immature

TABLE 2. Faunal composition (in number of specimens) of the Navatu midden by time period¹

Taxa	Late period	Middle period	Early period	Indet. period	Total
Human	103 (19%)	128 (29%)	92 (35%)	11 (31%)	334 (26%)
Mammal CBH ²	54 (10%)	48 (11%)	36 (14%)	6 (17%)	144 (11%)
Med. Mammal	259 (47%)	124 (28%)	40 (15%)	7 (19%)	430 (33%)
Sm. Mammal	13 (2%)	13 (3%)	10 (4%)	1 (3%)	37 (3%)
Aves	34 (6%)	40 (9%)	16 (6%)	3 (8%)	93 (7%)
Reptilia	58 (10%)	62 (14%)	57 (21%)	6 (17%)	183 (14%)
Indet.	34 (6%)	24 (5%)	15 (6%)	2 (6%)	75 (6%)
Pisces	79	113	107	12	311
Total	634	552	373	48	1607

¹ Percentages are for taxa within a given time period, excluding fish.² Mammal, could be human.TABLE 3. Number of identified specimens (NISP), maximum number of individuals (MAXNI), and minimum number of individuals (MNI) for the Navatu midden human sample¹

Element	17A Late	17A Middle	17A Early	17A Indet.	17B Middle	17B Early	Total
Frontal	9/8/3	1/1/1	9/6/1	—	—	—	19/15/5
Parietal	3/3/1	3/3/1	11/4/1	4/4/1	—	—	22/15/3
Temporal	11/10/5	1/1/1	1/1/1	—	—	—	13/12/7
Occipital	4/4/1	3/3/1	2/2/1	—	2/2/1	—	11/11/3
Sphenoid	2/2/1	—	—	—	—	—	2/2/1
Palatine	1/1/1	—	—	—	—	—	1/1/1
Zygomatic	—	1/1/1	—	—	—	—	1/1/1
Maxilla	3/3/1	2/2/1	6/6/2	—	—	—	11/11/4
Mandible	1/1/1	2/2/1	1/1/1	—	—	—	4/4/3
Teeth	7/7/2	6/6/2	14/13/2	2/2/1	4/4/1	—	33/32/6
Clavicle	1/1/1	—	—	—	—	—	1/1/1
Sternum	—	—	—	—	1/1/1	—	1/1/1
Rib	4/4/1	1/1/1	2/2/1	—	2/2/1	—	9/9/3
Atlas Vert.	—	—	—	—	1/1/1	—	1/1/1
Cervical Vert.	1/1/1	1/1/1	—	—	—	—	2/2/2
Thoracic Vert.	1/1/1	—	3/3/1	—	1/1/1	—	5/5/3
Lumbar Vert.	—	3/2/1	1/1/1	—	—	—	4/3/2
Humerus	3/3/1	5/2/2	2/2/2	—	1/1/1	—	11/8/6
Radius	1/1/1	8/4/1	—	—	—	—	9/5/2
Ulna	—	6/3/1	—	—	3/3/1	2/1/1	11/7/3
Carpals	—	1/1/1	—	—	—	—	1/1/1
Metacarpals	2/2/1	2/2/1	2/2/1	—	—	—	6/6/3
Prox. Hand Phx.	2/2/1	5/5/1	2/2/1	—	—	1/1/1	10/10/3
Int. Hand Phx.	1/1/1	2/2/1	1/1/1	—	—	—	4/4/3
Term. Hand Phx.	1/1/1	—	1/1/1	—	—	—	2/2/2
Indet. Hand Phx.	—	3/3/1	2/2/1	—	—	—	5/5/2
Femur	2/2/1	19/9/2	—	—	—	—	21/11/3
Tibia	5/4/1	2/1/1	—	—	—	—	7/5/2
Fibula	—	1/1/1	—	—	1/1/1	—	2/2/2
Talus	1/1/1	1/1/1	—	—	2/2/1	—	4/4/3
Other Tarsals	—	1/1/1	—	—	1/1/1	—	2/2/2
Metatarsals	1/1/1	2/2/1	—	—	—	—	3/3/2
Prox. Foot Phx.	—	—	1/1/1	—	1/1/1	—	2/2/2
Int. Foot Phx.	1/1/1	—	—	—	—	—	1/1/1
Indet. Foot Phx.	1/1/1	—	—	—	—	—	1/1/1
ICR1	4/x/x	1/x/x	9/x/x	2/x/x	2/x/x	—	18/x/x
ICR2	14/x/x	5/x/x	6/x/x	2/x/x	3/x/x	—	30/x/x
IP1	6/x/x	3/x/x	4/x/x	1/x/x	2/x/x	—	16/x/x
IP2	4/x/x	2/x/x	3/x/x	—	4/x/x	—	30/x/x
IP3	1/x/x	—	1/x/x	—	—	—	2/x/x
IP4	5/x/x	1/x/x	5/x/x	—	2/x/x	—	13/x/x

¹ Numbers in table are NISP/MAXNI/MNI. ICR1 = frontal or parietal; ICR2 = frontal, parietal, temporal squama, or occipital; IP1 = radius, ulna, or fibula; IP2 = humerus, femur, or tibia; IP3 = femur or tibia; IP4 = indet. postcranial.

individuals as indicated by several fragments with unfused epiphyses in both the Late and Middle periods of locus 17A. The overall MNI in the human burial sample is

nine, based on seven adult right femurs and two pairs of antimeric immature temporal bones. Conjoining was not undertaken for the burial sample, but the effect on the MNI

should be minimal given the relatively intact nature of the burials.

METHODS

The unit of analysis was the piece of bone, or specimen. A small portion of the sample (<1%) had been previously been subjected to reconstruction attempts. All glued joins in the midden sample were dissolved prior to analysis. Those joins across obviously modern breaks (using the criteria of White, 1992) were then reglued. For the burials, joins were only "conceptually" dissolved due to curatorial concerns. That is, the various pieces making up the reconstructed element were scored as separate specimens despite being physically connected.

A few unreconstructed specimens had breaks that were obviously modern and had probably occurred in transport or curation of the collection. Midden specimens with modern breaks were compared with every other specimen from the same excavation square and level for a match across the modern break. Such joins were reglued prior to analysis. A similar procedure was followed for the burials, but the joins were "conceptual." That is, the pieces participating in the join were scored as a single specimen despite being physically separated.

Every specimen was then scored for a variety of characteristics (element and taxonomic identification, burning, cutmarks, peeling, etc.). The attributes and their definitions were taken from White (1992). All specimens were examined under unidirectional incandescent incident light. Potential modifications were assessed using a 10× hand lens and/or a stereo zoom microscope (10× to 50×). The three criteria for highly accurate recognition of modifications proposed by Blumenschine et al. (1996) — experienced analyst, consistent application of criteria, and proper lighting and magnification — are considered to have been met in this analysis. Any modification judged due to excavation or preparation damage was not scored as present. Data were collected on the midden specimens by excavation rectangle and level to help prevent any observer bias that might be introduced by analyzing the human remains separately. To ensure consistent identification of two important

modifications, all specimens that might possibly exhibit cutmarks or percussion pits were identified in the initial round of analysis. Then, in one session, all bones (human and nonhuman) with possible cutmarks or percussion pits were scored for those modifications with frequent cross-checking between specimens to ensure consistent application of the recognition criteria.

Modification frequencies are presented here as the percentage of scorable specimens on which the particular modification is found. The statistical significance of differences in modification frequencies between taxa and time periods was assessed using Fisher's exact χ^2 test with Yate's correction ($\alpha = 0.05$). All *p*-values reported are two-sided and refer to this test.

After all modification data were collected, maximal conjoining (*sensu* White, 1992) was done for the midden human specimens that had been identified to a specific element, and the MNI values tabulated. All modification data presented here are from the unconjoined collection. The analytical categories commonly used are "midden human sample" (human remains from within the midden, either locus 17A or 17B), "medium mammal sample" (remains of medium-sized mammals from within the midden, either locus 17A or 17B), and "burials" (the human remains from the formal human burial locus outside the midden).

RESULTS

Human element representation

The postcranial element representation in the midden human sample and burial sample is shown in Figure 2. The bars in the chart indicate what percentage of each postcranial sample is composed of specimens from the listed elements; i.e., what percentage of the number of identified specimens (%NISP) are from each element. Specimens not identified to element (i.e., small fragments of long bone shafts) were not included in the calculation. The "normal" bars represent what the percentages would be for a single complete human skeleton. Figure 3 compares the human postcranial element representation in the Navatu midden and burials with that of a sample of canid-modified human burials from prehistoric

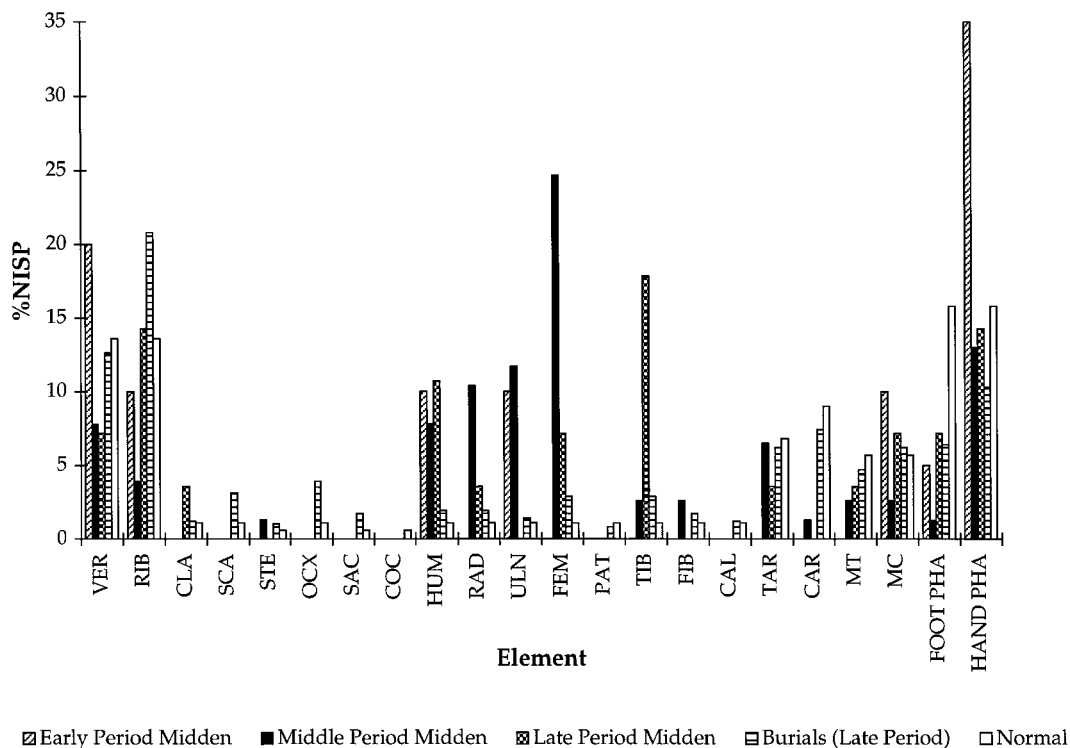


Fig. 2. Postcranial element representation in the Navatu human samples. The bars indicate the percentage of identified postcranial specimens that are from each element. The "normal" bars show what the element representation would be in a single complete skeleton.

Illinois (30 individuals; Milner and Smith, 1989).

The postcranial element representation in the midden human sample varies considerably by time period, probably due to the limited sample size. In all periods, though, it differs notably from both the "normal" and "carnivore-modified" distributions (Figs. 2 and 3). There is also a distinct difference between the element representation of the Late Period midden human sample and the contemporaneous burial sample (Fig. 2).

In the midden, 49% of all human specimens are cranial or mandibular (165 out of 334), while the proportion in the burials is 11% (66 out of 582). Part of the difference between the two samples is likely due to the greater fragmentation of the midden sample. The human cranial specimens in the midden are mostly from the neurocranium: 86% of specimens are from the cranial vault, while the proportion in a complete, disarticu-

lated skull is 32% (teeth are not included in either figure). The distribution in the burial cranial sample is qualitatively less biased toward the vault, but this sample cannot be assessed by cranial element since it contains complete crania.

In general, the midden human sample is composed of cranial vaults, arms, hands, and legs. Not a single fragment from the pelvic girdle or scapula is present in the midden human sample, and only one each from the sternum and clavicle. The preponderance of hand phalanges over foot phalanges is intriguing, given the anatomical similarities of those elements. The burial sample has a pattern of element representation resembling that found in complete skeletons.

Quantitative comparisons of element representation between the midden taxa would not be informative due to analyst bias. The author, as a human osteologist, is better at

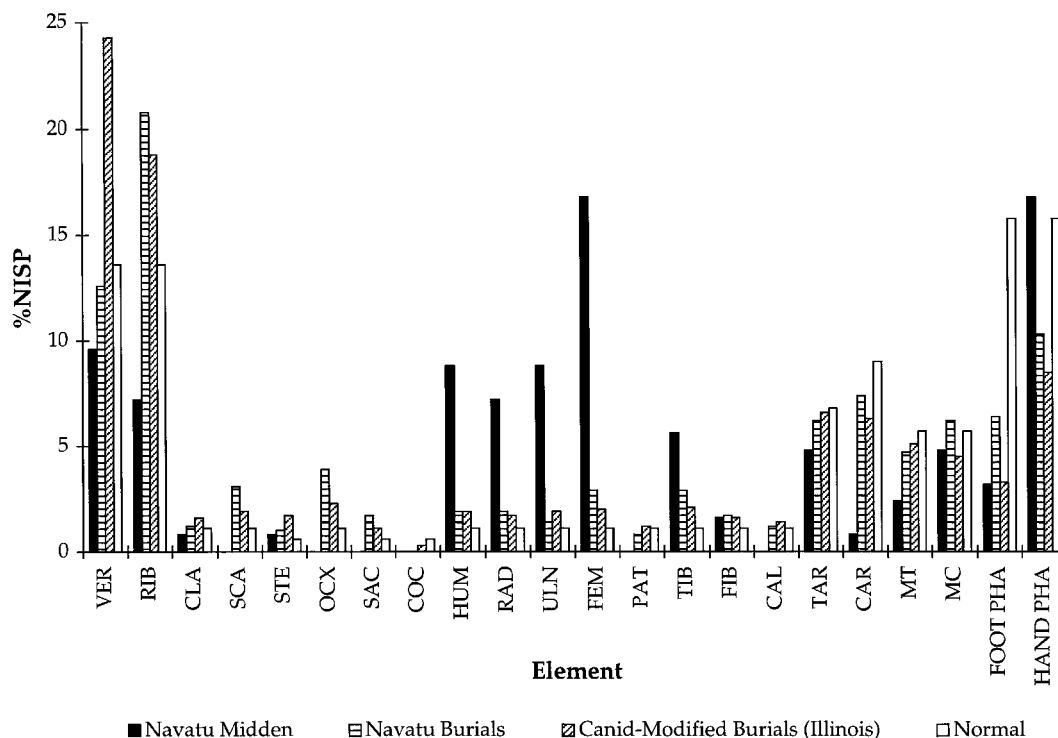


Fig. 3. Postcranial element representation in the Navatu human samples compared to canid-modified burials from Illinois (Milner and Smith, 1989). The bars are as in Fig. 2.

identifying human bone fragments to element than at doing the same for nonhuman bone fragments. So an abundance of, say, human humerus shaft fragments relative to pig humerus shaft fragments would be more indicative of the identification process than of any prehistoric human behavior.

Fragmentation

The most obvious characteristic of the midden sample is the high degree of fragmentation. The longest dimension of most specimens in the midden is less than ≈ 4 cm, while the burial specimens are more intact. Each specimen was evaluated for fracture surfaces of ancient, modern, and indeterminate origin. The antiquity of breaks was judged based on the correspondence in color, patina, matrix adhesion, and texture between the broken surface and the rest of the specimen (Lyman and O'Brien, 1987; White, 1992). If the break surface matched the rest of the specimen, the fracture was judged ancient; if not, the fracture was judged

modern. Ambiguous cases were scored as fractures of indeterminate antiquity. The number of specimens with ancient breaks is given in Table 4 by taxa and time period. The rate of ancient fractures does not differ significantly between the midden human remains and the medium mammal remains ($p = 0.074$). There are significant differences between both of those and the burial sample ($p < 0.001$).

The degree of fragmentation was roughly quantified by scoring each specimen as "whole" if it represented more than half of the element, or "fragmentary" if it represented less than half (White, 1992). Nonhuman specimens not identified to element were scored as indeterminate for this category. Human specimens not identified to element were only scored as "fragmentary" if they would represent less than half of any element they might possibly be. The number of fragmentary specimens is given in Table 5 by taxa and time period. The midden human remains are significantly more fragmentary

TABLE 4. *Ancient breaks in the Navatu sample*¹

Locus and period	Burials	Midden human	Med. mammal	Sm. mammal	Aves	Reptilia	Pisces
17A Late	360/581 (62%)	94/103 (91%)	223/259 (86%)	12/13 (92%)	34/34 (100%)	58/58 (100%)	79/79 (100%)
17A Middle	—	83/93 (89%)	93/105 (89%)	9/13 (69%)	35/37 (95%)	41/42 (98%)	90/91 (99%)
17A Early	—	84/89 (94%)	33/35 (94%)	8/9 (9%)	16/16 (100%)	56/56 (100%)	104/104 (100%)
17A Indet.	—	11/11 (100%)	7/7 (100%)	1/1 (100%)	3/3 (100%)	6/6 (100%)	11/11 (100%)
17A Subtotal	360/581 (62%)	272/296 (92%)	356/406 (88%)	30/36 (83%)	88/90 (98%)	161/162 (99%)	284/285 (100%)
17B Middle	—	32/35 (91%)	17/19 (90%)	0/0	3/3 (100%)	20/20 (100%)	22/23 (96%)
17B Early	—	3/3 (100%)	5/5 (100%)	1/1 (100%)	0/0	1/1 (100%)	3/3 (100%)
17B Subtotal	—	35/38 (92%)	22/24 (92%)	1/1 (100%)	3/3 (100%)	21/21 (100%)	25/26 (96%)
Total	360/581 (62%)	307/334 (92%)	378/430 (88%)	31/37 (84%)	91/93 (98%)	182/183 (100%)	309/311 (99%)

¹ Figures in the table are number of specimens with an ancient break/total number of scorable specimens (percentage affected).

than the medium mammal remains ($p < 0.001$). Both of these samples are significantly more fragmentary than the human burials ($p < 0.001$). There are also some significant differences in fragmentation between the various nonhuman taxa, most notably between the medium mammals and the birds ($p = 0.005$).

Some of the apparent difference in fragmentation between the midden human and nonhuman samples may be due to the author's greater proficiency at identifying fragmentary human remains to element than for nonhuman remains. Since only the more complete nonhuman specimens were identified to element, the analysis of the nonhuman material is probably biased in favor of "whole" specimens.

Turner and Turner (1999) define "fragmentary" specimens as those with less than 95% of the element present, as opposed to the 50% cutoff used by White (1992) and this study. If the Turner and Turner (1999) definition were used, virtually every specimen in the Navatu midden would be classified as a "fragment."

The portion of the bone preserved was recorded for all tubular elements as either complete (shaft plus portions of both articular ends), shaft only, proximal end only, distal end only, proximal end plus shaft, or distal end plus shaft (White, 1992). The portions preserved for the midden and burial samples are given in Table 6. There is no significant difference between the portions preserved for the midden human remains and the medium mammal remains. Both are significantly different than the burial sample; the burials have far more "complete" tubular elements and relatively few "shaft only" specimens.

The shaft circumference preserved was recorded for all tubular elements retaining any portion of the shaft. The maximum enclosure of the marrow cavity was scored as either <50% of the shaft circumference preserved, >50% but <100% preserved, or 100% preserved (White, 1992). The circumference preserved in the midden and burial specimens is given in Table 7. The midden human and medium mammal samples are

TABLE 5. "Fragmentary" specimens in the Navatu sample¹

Locus and period	Burials	Midden human	Med. mammal	Sm. mammal	Aves	Reptilia	Pisces
17A Late	143/420 (34%)	82/99 (83%)	88/153 (58%)	6/10 (60%)	6/6 (100%)	2/3 (67%)	0/0
17A Middle	—	65/86 (76%)	40/65 (62%)	3/10 (30%)	14/17 (82%)	0/0	4/4 (100%)
17A Early	—	69/83 (83%)	19/21 (91%)	1/9 (11%)	4/5 (80%)	5/5 (100%)	3/3 (100%)
17A Indet.	—	10/11 (91%)	4/4 (100%)	1/1 (100%)	3/3 (100%)	0/0	0/0
17A Subtotal	143/420 (34%)	226/279 (81%)	151/243 (62%)	11/30 (37%)	27/31 (87%)	7/8 (88%)	7/7 (100%)
17B Middle	—	26/32 (81%)	10/11 (91%)	0/0	1/1 (100%)	0/0	0/0
17B Early	—	2/3 (67%)	1/2 (50%)	1/1 (100%)	0/0	0/0	0/0
17B Subtotal	—	28/35 (80%)	11/13 (85%)	1/1 (100%)	1/1 (100%)	0/0	0/0
Total	143/420 (34%)	254/314 (81%)	162/256 (63%)	12/31 (39%)	28/32 (88%)	7/8 (88%)	7/7 (100%)

¹ Figures in the table are number of "fragmentary" specimens/total number of scorable specimens (percentage affected).

almost identical in the proportions of the circumference preservation scores. Both are significantly different from the human burial sample, in which virtually all tubular specimens have completely enclosed marrow cavities.

Incipient fracture cracks

Incipient fracture cracks are fissures in the bones that partly or completely cross the bone surface, but are not minor hairline cracks (White, 1992). The number of specimens in the sample with incipient fracture cracks is given in Table 8. The midden human sample, both from the Late Period and overall, has a significantly higher rate of incipient fracture cracks than the human burials ($p = 0.046$ and 0.022 , respectively). Within the midden, there are no significant differences in the rate of incipient fracture cracks between the taxa. Overall, the midden sample has a lower rate of incipient fracture cracks in the Early period relative to the Middle and Late periods, but these differences are not significant. Most cracked specimens in the midden have only a single crack (20 of 27), the rest have two separate cracks. There does not appear to be any significant element patterning of incipient fracture cracks in any taxa.

Conjoining

After all modification data were collected, the midden human specimens identified to element were subjected to maximal conjoining (sensu White, 1992). The results are given in Table 9. The conjoining data refer only to joins across ancient breaks; fractures of recent origin were repaired prior to the collection of modification data. No joins were

found that crossed excavation squares or levels. The burials were not subjected to conjoining due to museum access constraints. Most specimens participating in joins were from long bones, though some cranial specimens were also found to conjoin.

Weathering

Behrensmeyer's (1978) six stage weathering scale was used to assess the degree of weathering. The weathering scores do not carry any implications about the duration of surface exposure of the bones (White, 1992), but do provide an indication of both the general preservation and relative rates of weathering between the various time periods and loci of this sample. The sample is relatively unweathered, with almost all specimens scoring zero or one (Table 10). The degree of weathering in the locus 17A sample is almost identical to the burials, while the locus 17B remains are somewhat more weathered. The weathering does not vary appreciably between taxa, and there are no notable differences in weathering scores between time periods.

Random striae

Random striae are marks that, while superficially similar to cutmarks, are shallow and random in their orientation on the bone. They also tend to be most intense on projecting areas of the bone (White, 1992). Random striae are usually interpreted as the result of cave rockfalls, animal trampling, or mechanical abrasion by sand (Fiorillo, 1989). Seven specimens in the midden sample, all from locus 17A, have random striae out of 1,592 specimens scorable for this modification: three are human, three are medium

TABLE 6. Portions of tubular bones preserved in Navatu sample¹

Locus and period	Complete bone			Proximal/distal end plus shaft			Proximal/distal end only			Shaft only		
	Burials	Midden human	Med. mammal	Burials	Midden human	Med. mammal	Burials	Midden human	Med. mammal	Burials	Midden human	Med. mammal
17A Late	129 (58%)	4 (11%)	19 (18%)	37 (17%)	4 (11%)	22 (21%)	18 (8%)	2 (5%)	5 (5%)	39 (18%)	27 (73%)	57 (55%)
17A Middle	—	4 (7%)	4 (10%)	—	11 (18%)	11 (28%)	—	12 (20%)	4 (10%)	—	33 (50%)	21 (53%)
17A Early	—	3 (13%)	0	—	3 (13%)	0	—	0	1 (5%)	—	18 (75%)	18 (95%)
17A Indet.	—	0	0	—	0	0	—	0	0	—	1 (100%)	5 (100%)
17A Subtotal	129 (58%)	11 (9%)	23 (14%)	37 (17%)	18 (15%)	33 (20%)	18 (8%)	14 (11%)	10 (6%)	39 (18%)	79 (65%)	101 (60%)
17B Middle	—	1 (8%)	0	—	1 (8%)	1 (8%)	—	0	1 (8%)	—	11 (85%)	10 (83%)
17B Early	—	0	—	—	1 (33%)	—	—	1 (33%)	—	—	1 (33%)	—
17B Subtotal	—	1 (6%)	0	—	2 (13%)	1 (8%)	—	1 (6%)	1 (8%)	—	12 (75%)	10 (83%)
Total	129 (58%)	12 (9%)	23 (13%)	37 (17%)	20 (14%)	34 (19%)	18 (8%)	15 (11%)	11 (6%)	39 (18%)	91 (66%)	111 (62%)

¹ Figures in the table are number of specimens (percentage of all scorable specimens in that time period).

mammal, and one is indeterminate (not human). No specimens in the burials have random striae.

Bitemarks

Each specimen was evaluated for the presence of carnivore bitemarks, rodent gnawing, and bitemarks of uncertain origin. No specimen in the midden sample has more than one kind of bitemark, and no bitemarks are present in the burials. Carnivore bitemarks were diagnosed based on the presence of circular perforations of the bone and associated striae (Binford, 1981; Blumenschine et al., 1996; White, 1991). The term "carnivore" is used here to refer to dietary behavior, not to the order Carnivora. The taxa known from Viti Levu that might produce carnivore bitemarks are dogs, pigs, goats, and humans. The carnivore bitemarks observed are of a size consistent with a canid, though the possibility that some of them are human bitemarks cannot be ruled out (White, 1992). Overall, 22 of 1593 specimens (1%) in the midden have carnivore bitemarks. The midden human sample has a significantly lower incidence of carnivore bites than does the medium mammal sample (1% versus 3%, $p = 0.049$). The two human specimens with carnivore bitemarks are fragments of temporal and radius shaft.

Rodent gnawing was diagnosed based on the presence of parallel indentations (Haglund, 1992; White, 1991). The gnawing in the midden sample is of a size consistent with the rat species known from the site (*Rattus exulans* and *Rattus norvegicus*). Overall, 75 of 1593 specimens (5%) in the midden have rodent gnawing. The midden human and medium mammal samples do not differ significantly in the frequency of rodent gnawing (6% versus 8%, $p = 0.324$). The human specimens with rodent gnawing are mostly postcranial (17 out of 20) and include a wide variety of elements.

Some modifications were observed that, while clearly the result of a tooth impact, could not be unambiguously assigned to either rodent gnawing or carnivore action. These were tabulated as bitemarks of uncertain origin, and occur on 11 of 1593 specimens (1%) in the midden sample. The midden human and medium mammal samples

TABLE 7. Shaft circumference of tubular bones in Navatu sample¹

Locus and period	<50% of shaft circumference			>50% of shaft circumference, <100%			100% of shaft circumference		
	Burials	Midden human	Med. mammal	Burials	Midden human	Med. mammal	Burials	Midden human	Med. mammal
17A Late	10 (5%)	20 (57%)	45 (45%)	3 (2%)	5 (14%)	7 (7%)	192 (94%)	10 (29%)	48 (48%)
17A Middle	—	25 (52%)	18 (49%)	—	2 (4%)	1 (3%)	—	21 (44%)	18 (49%)
17A Early	—	13 (54%)	14 (78%)	—	1 (4%)	4 (22%)	—	10 (42%)	0
17A Indet.	—	1 (100%)	3 (60%)	—	0	0	—	0	2 (40%)
17A Subtotal	10 (5%)	59 (55%)	80 (50%)	3 (2%)	8 (7%)	12 (8%)	192 (94%)	41 (38%)	68 (43%)
17B Middle	—	5 (38%)	8 (73%)	—	0	0	—	8 (62%)	3 (27%)
17B Early	—	0	—	—	0	—	—	2 (100%)	—
17B Subtotal	—	5 (33%)	8 (73%)	—	0	0	—	10 (67%)	3 (27%)
Total	10 (5%)	64 (52%)	88 (51%)	3 (2%)	8 (7%)	12 (7%)	192 (94%)	51 (41%)	71 (42%)

¹ Figures in the table are number of specimens (percentage of all scorable specimens in that time period).

TABLE 8. Incipient fracture cracks in the Navatu sample¹

Locus and period	Burials	Midden human	Med. mammal	Aves	Midden total
17A Late	3/582 (1%)	3/102 (3%)	7/259 (3%)	2/34 (6%)	12/631 (2%)
17A Middle	—	3/93 (3%)	4/105 (4%)	2/37 (5%)	9/439 (2%)
17A Early	—	1/87 (1%)	0/35 (0%)	1/17 (6%)	3/359 (1%)
17A Indet.	—	0/11 (0%)	0/7 (0%)	0/2 (0%)	0/46 (0%)
17A Subtotal	3/582 (1%)	7/293 (2%)	11/406 (3%)	5/90 (6%)	24/1475 (2%)
17B Middle	—	1/35 (3%)	1/19 (5%)	0/3 (0%)	3/114 (3%)
17B Early	—	0/3 (0%)	0/5 (0%)	0/0	0/13 (0%)
17B Subtotal	—	1/38 (3%)	1/24 (4%)	0/3 (0%)	3/127 (3%)
Total	3/582 (1%)	8/331 (2%)	12/430 (3%)	5/93 (5%)	27/1602 (2%)

¹ Figures in the table are number of specimens with an incipient fracture crack/total number of scorable specimens (percentage affected).

TABLE 9. Conjoining in Navatu midden human sample¹

Locus and period	Specimens conjoining
17A Late	6/69 (9%)
17A Middle	30/81 (37%)
17A Early	18/61 (30%)
17A Indet.	2/6 (33%)
17A Subtotal	56/217 (26%)
17B Middle	0/22 (0%)
17B Early	2/3 (67%)
17B Subtotal	2/25 (8%)
Total	58/242 (24%)

¹ Figures in table are number of specimens participating in joins/total number of specimens checked for joins (percentage joining).

have the same frequency of these marks (1%).

Burning

Specimens were scored as burned if they exhibited either severe discoloration (i.e., blackened or calcined) or a combination of moderate discoloration and exfoliation of the bone surface (White, 1992). The range of thermal alteration observed in the midden human sample is illustrated in Figure 4.

The frequency of burning in the sample is given in Table 11. No burning was observed in the human burials. It was generally not possible to assess the patterning of the burning relative to soft tissue cover due to the small size of most specimens. Of the 94 burned midden human specimens, 13 were fleshed when burned while four were not. Of the 47 burned medium mammal specimens, eight were fleshed when burned while eight were not.

The remains from the Early Period at locus 17A have a significantly higher incidence of burning across all taxa than do the remains from the Middle and Late Periods (Table 11). This may be due to the presence in the midden of several small hearths or ovens — identified by Gifford (1951) on the basis of ashes and “oven stones” — but the stratigraphic distribution of these features is unknown. Overall, the remains from locus 17A have a significantly higher incidence of burning than do those from 17B ($p < 0.001$). There are also significant differences in the frequency of burning between the various

TABLE 10. Weathering scores for specimens in the Navatu sample^{1,2}

Weathering score	Burials	17A midden human	17A med. mammal	17A total	17B midden human	17B med. mammal	17B total	Midden total
Zero	413 (70%)	208 (71%)	295 (73%)	1063 (72%)	17 (45%)	10 (42%)	40 (32%)	1103 (69%)
One	175 (30%)	83 (28%)	109 (27%)	399 (27%)	19 (50%)	14 (58%)	84 (66%)	483 (30%)
Two	1 (0.2%)	1 (0.3%)	0 (0%)	6 (0.4%)	2 (5%)	0 (0%)	3 (2%)	9 (0.6%)
Mean Score	0.30	0.29	0.27	0.28	0.61	0.58	0.71	0.30

¹ Weathering stages are from Behrensmeyer (1978).

² Figures in table are number of specimens (percentage for that locus/taxon).



Fig. 4. Human specimens from the Navatu midden illustrating the range of thermal alteration in the sample.

taxa. In the Early Period of 17A, for example, the human remains are significantly more burnt than those of any other taxa except reptiles ($p = 0.170$). In the overall incidence of burning, two groups of taxa can be discerned: the humans, reptiles, and fish form one group, and the medium mammals, small mammals, and birds form the other. The frequency differences between taxa in the same group are not statistically significant, while those between taxa in different groups are highly significant.

The burning in the midden human sample is focused on the head: 67 of 165 scorable cranial and mandibular specimens are

burned (41%), while only 27 of the 165 scorable postcranial specimens are (16%), a significant difference ($p < 0.0001$). The cranial remains with burning are, like the cranial assemblage itself, mainly vault fragments, though fragments of zygomatic, maxilla, and mandible also exhibit burning. The identified postcranial elements with burning include nine hand bone specimens, three femur fragments, and fragments of a foot phalange, rib, and thoracic vertebra.

Cutmarks

Cutmarks (Fig. 5) were identified in the sample using the recognition criteria out-

TABLE 11. *Burning in the Navatu sample*¹

Locus and period	Burials	Midden human	Med. mammal	Sm. mammal	Aves	Reptilia	Pisces	Midden total
17A Late	0/582 (0%)	17/102 (17%)	21/259 (8%)	0/13 (0%)	0/34 (0%)	6/58 (10%)	11/79 (14%)	66/633 (10%)
17A Middle	—	14/92 (15%)	9/105 (9%)	1/13 (8%)	4/37 (11%)	4/42 (10%)	8/91 (9%)	44/438 (10%)
17A Early	—	54/89 (61%)	12/34 (35%)	1/9 (11%)	5/16 (31%)	27/56 (48%)	42/104 (40%)	154/359 (43%)
17A Indet.	—	6/11 (55%)	3/7 (43%)	0/1 (0%)	0/3 (0%)	1/6 (17%)	4/11 (36%)	15/47 (32%)
17A Subtotal	0/582 (0%)	91/294 (31%)	45/405 (11%)	2/36 (6%)	9/90 (10%)	38/162 (24%)	65/285 (23%)	279/1477 (19%)
17B Middle	—	3/33 (9%)	2/19 (11%)	0/0	0/3 (0%)	0/20 (0%)	2/23 (9%)	7/112 (6%)
17B Early	—	0/3 (0%)	0/5 (0%)	0/1 (0%)	0/0	0/1 (0%)	1/3 (33%)	1/13 (8%)
17B Subtotal	—	3/36 (8%)	2/24 (8%)	0/1 (0%)	0/3 (0%)	0/21 (0%)	3/26 (12%)	8/125 (6%)
Total	0/582 (0%)	94/330 (29%)	47/429 (11%)	2/37 (5%)	9/93 (10%)	38/183 (21%)	68/311 (22%)	287/1602 (18%)

¹ Figures in the table are number of specimens with burning/total number of scorable specimens (percentage affected).

lined by White (1992). The frequency of cutmarks is given in Table 12. Seven cow bones found on the surface of locus 17A have very deep cutmarks indicative of the use of metal implements, and are not included in the tabulation. The human burials contain only one cutmarked specimen, a complete left femur.

There are no significant differences between the frequency of cutmarks on the midden human and medium mammal remains in any time period or overall. The difference in the overall rate of cutmarks between the midden human sample and the human burials is highly significant ($p < 0.0001$), as is the difference between the human burials and the contemporaneous Late Period midden human remains ($p < 0.0001$). The frequency of cutmarks in the entire midden assemblage does not differ significantly between the time periods or between locus 17A and 17B. The number of cutmarks on each cutmarked specimen was estimated, but such estimations have a significant subjective component (White, 1992). Most cutmarked human specimens have one or two cutmarks, with a mean of 2.1 and a maximum of seven. The cutmarked medium mammal specimens have an average of 1.8 cutmarks each, with a maximum of five.

The cutmarks in the midden human sample are focused on the postcranial elements: 20 of 166 scorable postcranial specimens have cutmarks (12%), while only 10 of the 159 scorable cranial specimens do (6%), a difference which is not quite statistically significant ($p = 0.086$). The cutmarked postcranial elements are exclusively limb bones, while the cutmarked cranial elements are mostly vault fragments.

Most of the cutmarks in the midden sample are shallow and short (<2 cm). Gifford recovered many shell tools, including knives, from the midden, but only 14 fragments of stone tools were located (Gifford, 1951). It is possible that molluscan shell knives (Toth and Woods, 1989) and/or bamboo tools (Spennemann, 1987; West, 1989) made at least a portion of the cutmarks in the present sample. Ethnographic and historical records document the use of such tools in Fiji (Spennemann, 1987).

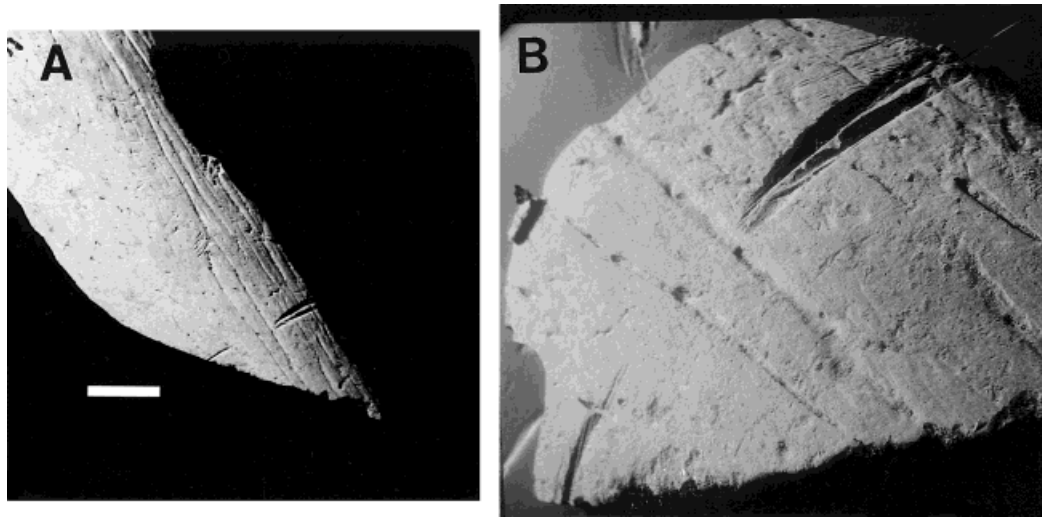


Fig. 5. Cutmarked human specimen from the Navatu midden (A) and a scanning electron micrograph of the cutmarked region (B). The white bar is 5 mm long in all photos.

TABLE 12. *Cutmarks in the Navatu sample*¹

Locus and period	Burials	Midden human	Med. mammal	Sm. mammal	Aves	Reptilia	Pisces	Midden total
17A Late	1/582 (0.2%)	6/102 (6%)	20/252 (8%)	0/13 (0%)	1/34 (3%)	2/58 (3%)	3/79 (4%)	35/624 (6%)
17A Middle	—	9/91 (10%)	6/105 (6%)	0/13 (0%)	1/37 (3%)	0/42 (0%)	1/90 (1%)	19/435 (4%)
17A Early	—	7/84 (8%)	6/34 (18%)	0/9 (0%)	0/16 (0%)	2/56 (4%)	1/104 (1%)	19/354 (5%)
17A Indet.	—	2/11 (18%)	2/6 (33%)	0/1 (0%)	0/3 (0%)	0/6 (0%)	0/10 (0%)	4/45 (9%)
17A Subtotal	1/582 (0.2%)	24/288 (8%)	34/397 (9%)	0/36 (0%)	2/90 (2%)	4/162 (3%)	5/283 (2%)	77/1458 (5%)
17B Middle	—	5/34 (15%)	1/19 (5%)	0/0	0/3 (0%)	0/20 (0%)	0/23 (0%)	6/113 (5%)
17B Early	—	1/3 (33%)	0/5 (0%)	0/1 (0%)	0/0	0/1 (0%)	0/3 (0%)	1/13 (8%)
17B Subtotal	—	6/37 (16%)	1/24 (4%)	0/1 (0%)	0/3 (0%)	0/21 (0%)	0/26 (0%)	7/126 (6%)
Total	1/582 (0.2%)	30/325 (9%)	35/421 (8%)	0/37 (0%)	2/93 (2%)	4/183 (2%)	5/309 (2%)	84/1584 (5%)

¹ Figures in the table are number of specimens with cutmarks/total number of scorable specimens (percentage affected).

The midden also contains direct evidence for the use of shell tools on human remains: a proximal hand phalange from the Middle period of locus 17A has a piece of shell embedded in its proximal-dorsal base (Fig. 6). There is no trace of resorption or bone deposition, so the insertion did not occur appreciably antemortem. The coloration and texture of this area are identical to the surrounding bone, so it did not occur appreciably postmortem. Therefore the shell fragment probably became lodged in the bone during disarticulation of the finger from the rest of the hand.

Percussion pits

Percussion pits are caused by the impact of a percussor that scars solid cortical bone

without causing inward crushing of the bone cortex (Fig. 7; White, 1992). They are roughly circular in outline, and are more irregular in internal topography and outline than carnivore tooth pits (Blumenschine et al., 1996). Only ten specimens in the sample, all from locus 17A, have percussion pits (Table 13). No specimens in the burials have percussion pits. There is no obvious patterning of the affected specimens by time period, but the sample of specimens with pits is very small. There are no significant differences between the overall rates of percussion pits in the midden taxa. The percussion pits in the human sample are found only on limb shafts (one femur fragment, two fragments from indeterminate long bones), and the same pattern is seen in the nonhuman remains.

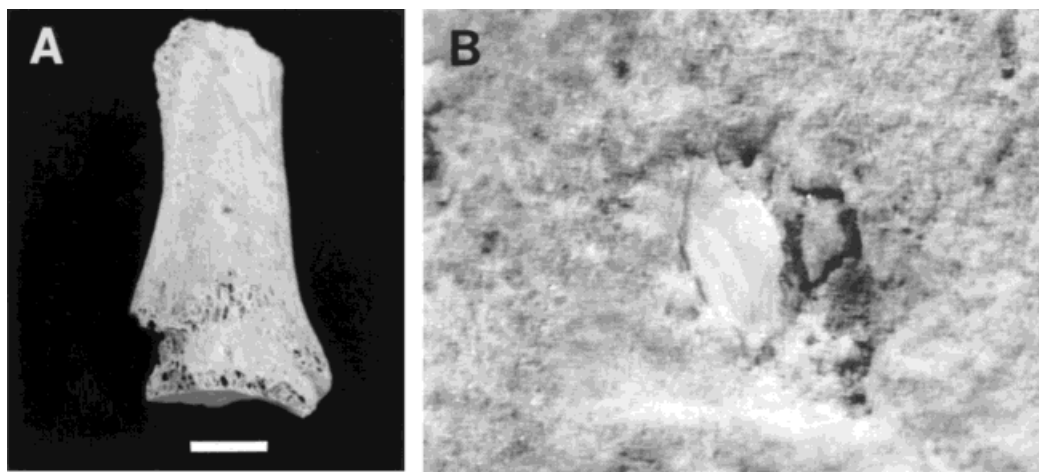


Fig. 6. Human proximal hand phalange from the Navatu midden with a shell fragment embedded in its proximal-dorsal surface (A). The associated matrix and lack of new bone formation (B) suggests implantation occurred perimortem.

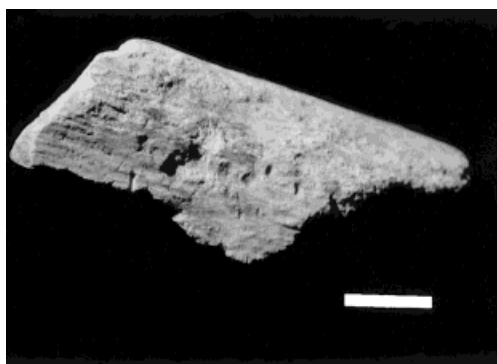


Fig. 7. Human femur fragment with percussion pits from the Navatu midden.

All the specimens have a single percussion pit, except the fish specimen (two) and the human femur fragment (six).

Peeling

Peeling is the characteristic pattern of exfoliation produced when a fresh bone is snapped in two (White, 1992). The resulting peeling apart of the two pieces produces a roughened, exfoliated surface with parallel grooves (Fig. 8). All tubular elements (long bones, nonterminal phalanges, metacarpals, and metatarsals) were scored for this characteristic, along with ribs and vertebral spines. Ten specimens in the sample exhibit peeling

(Table 14). All of these are from the midden, as no specimens in the burials have peeling. A higher rate of peeling is evident across all midden taxa in the Middle Period at locus 17A, but this difference is only significant between the Late and Middle Periods ($p = 0.011$). The midden human remains have a significantly higher incidence of peeling than do the medium mammal remains ($p = 0.020$), but do not differ significantly from the bird remains ($p = 0.714$). The human fragments with peeling are from a clavicle, a radius, an ulna, a proximal hand phalange, and two (conjoining) lumbar vertebrae specimens. The nonhuman specimens with peeling are all fragments of long bone shafts.

Crushing

Crushing is the inward displacement of cortical bone into the inner spongy bone space (Fig. 9). Crushing covers a larger area and has a more gradually sloped margin than do carnivore bitemarks and percussion pits, which typically consist of a sharp depression surrounded by uncrushed bone (White, 1992). Eleven specimens in the midden, all from locus 17A, have crushing (Table 15). One specimen in the burials, an ilium, exhibits crushing. There are no significant differences in the overall rates of crushing between the midden human, medium mammal, and fish samples ($p = 1.000$ for each),

TABLE 13. Percussion pits in the Navatu sample¹

Locus and period	Burials	Midden human	Med. mammal	Sm. mammal	Pisces	Midden total
17A Late	0/582 (0%)	0/102 (0%)	3/259 (1%)	0/13 (0%)	0/79 (0%)	3/631 (0.5%)
17A Middle	—	2/93 (2%)	1/105 (1%)	1/13 (8%)	0/90 (0%)	4/437 (1%)
17A Early	—	1/84 (1%)	0/35 (0%)	0/9 (0%)	1/104 (0%)	2/355 (1%)
17A Indet.	—	0/11 (0%)	1/6 (17%)	0/1 (0%)	0/10 (0%)	1/45 (2%)
17A Subtotal	0/582 (0%)	3/290 (1%)	5/405 (1%)	1/36 (8%)	1/283 (0.4%)	10/1469 (1%)
17B Middle	—	0/34 (0%)	0/19 (0%)	0/0	0/23 (0%)	0/113 (0%)
17B Early	—	0/3 (0%)	0/5 (0%)	0/1 (0%)	0/3 (0%)	0/13 (0%)
17B Subtotal	—	0/37 (0%)	0/24 (0%)	0/1 (0%)	0/26 (0%)	0/126 (0%)
Total	0/582 (0%)	3/327 (1%)	5/429 (1%)	1/37 (3%)	1/309 (0.3%)	10/1595 (0.6%)

¹ Figures in the table are number of specimens with percussion pits/total number of scorable specimens (percentage affected).



Fig. 8. Human clavicle specimen with peeling from the Navatu midden.

nor is the difference between the midden human and burial samples significant ($p = 0.137$). The Middle Period at locus 17A has a somewhat elevated rate of crushing overall, but this is not statistically significant. All bones with crushing have only a single crushed area. The location of the crushing varies in the nonhuman remains, but it is confined to the articular ends of phalanges (two proximal hand, one intermediate foot) in the midden human sample.

Summary of Modifications

The human burial specimens are essentially unmodified, except for some ancient breakage. The midden specimens, both human and nonhuman, have a variety of modifications (Fig. 10). Ancient breakage, burning, and cutmarks are relatively common in both the midden human and medium mammal assemblages. Peeling, percussion pits, and crushing are also seen in the midden

sample, but are present on only a few specimens.

There is a general correspondence between the types and frequencies of modifications in the midden human sample and the medium mammal sample (Fig. 10), but there are significant differences in the rates of burning and peeling. However, there are also significant differences in the frequency of burning between the various nonhuman taxa in the midden, and the frequency of peeling is not significantly different between the bird and human remains. The modification frequencies in the human burial sample are very different from the midden human and medium mammal samples (Fig. 11).

DISCUSSION

Agents of modification

Many agencies have the potential to modify archaeological skeletal remains. These include sediment pressure, weathering, waves, trampling by animals, and the actions of carnivores, rodents, and humans. The potential nonhuman causes of bone modification in the Navatu assemblage must be evaluated before inferences about human behavior can be drawn from the modification data.

If sediment pressure were a major cause of bone fragmentation, then specimens from the lower stratigraphic levels should be more fragmentary and have more incipient fracture cracks than those in the upper stratigraphic levels. The midden sample, though, has a roughly constant rate of fragmentation across all three time periods (Table 4). Incipient fracture cracks are actually more common in the upper levels than in the lower ones (Table 8). So while it is possible

TABLE 14. *Peeling in the Navatu tubular bone sample*¹

Locus and period	Burials	Midden human	Med. mammal	Aves	Midden total
17A Late	0/351 (0%)	1/40 (3%)	0/124 (0%)	0/30 (0%)	1/253 (0.4%)
17A Middle	—	3/53 (6%)	1/48 (2%)	2/33 (6%)	7/184 (4%)
17A Early	—	1/31 (3%)	0/21 (0%)	0/16 (0%)	1/113 (1%)
17A Indet.	—	0/1 (0%)	0/4 (0%)	0/2 (0%)	0/13 (0%)
17A Subtotal	0/351 (0%)	5/125 (4%)	1/197 (1%)	2/81 (2%)	9/564 (2%)
17B Middle	—	1/17 (6%)	0/12 (0%)	0/3 (0%)	1/37 (3%)
17B Early	—	0/2 (0%)	0/0	0/0	0/2 (0%)
17B Subtotal	—	1/19 (5%)	0/12 (0%)	0/3 (0%)	1/39 (3%)
Total	0/351 (0%)	6/144 (4%)	1/209 (0.5%)	2/84 (2%)	10/603 (2%)

¹ Figures in the table are number of specimens with peeling/total number of scorable specimens (percentage affected).

Fig. 9. Human proximal hand phalange with crushing at proximal base from the Navatu midden.

that a small percentage of the fragmentation is due to the weight of the overlying sediment, this process can be discounted as a major cause of bone breakage.

All the skeletal remains from Navatu are relatively unweathered (Table 10). The good preservation of the bone surfaces suggests that few modifications were deleted by weathering. The close correspondence in the degree of weathering between the midden and burial samples, and between the taxa in the midden sample, indicates that the modification frequencies were not biased by differential weathering across these samples.

Significant in situ decay of skeletal remains has been noted (Locock et al., 1992), particularly in coastal environments (e.g., Hanson and Butler, 1997; Rowland and Best, 1980). It is likely that natural decay contributed to the fragmentation of the Navatu remains. Significant decay would seem likely to result in equal fragmentation of small and large elements, but the midden human sample contains numerous relatively intact phalanges and only a few small fragments of tibia. Decay might also result in notable weathering or exfoliation of the bone surfaces (Behrensmeyer, 1978; Lyman and Fox, 1989), which is rare in the Navatu assemblage. So while natural decay and decomposition probably contributed to some of the fragmentation, there is no evidence that this process had a major effect on the Navatu skeletal remains.

Trampling and fluvatile sediment abrasion are predicted to result in random striae on bones (Fiorillo, 1989). Only seven specimens in the Navatu sample have random striae, so animal trampling and mechanical abrasion by sand cannot be considered to be major modifiers of this assemblage.

Since Navatu is close to the ocean, it is possible that wave action altered the element representation of the skeletal assemblage. Spannemann (1992) reported the effect of wave action on the element representation in a recent (AD 1885–1950) cemetery on Majuro Atoll, Marshall Islands. The pattern of element representation produced by wave action on complete skeletons differs dramatically from that seen in the Navatu midden human sample. For example, elements such as the mandible, tibia, and fibula are very well-represented in the

TABLE 15. *Crushing in the Navatu sample*¹

Locus and period	Burials	Midden human	Med. mammal	Pisces	Midden total
17A Late	1/582 (0.2%)	1/102 (1%)	1/259 (0.4%)	0/79 (0%)	2/631 (0.3%)
17A Middle	—	2/93 (2%)	2/105 (2%)	1/91 (1%)	6/439 (1%)
17A Early	—	0/85 (0%)	0/35 (0%)	2/104 (2%)	2/356 (1%)
17A Indet.	—	0/11 (0%)	1/7 (14%)	0/10 (0%)	1/46 (2%)
17A Subtotal	1/582 (0.2%)	3/291 (1%)	4/406 (1%)	3/284 (1%)	11/1472 (1%)
17B Middle	—	0/35 (0%)	0/19 (0%)	0/23 (0%)	0/114 (0%)
17B Early	—	0/3 (0%)	0/5 (0%)	0/3 (0%)	0/13 (0%)
17B Subtotal	—	0/38 (0%)	0/24 (0%)	0/26 (0%)	0/127 (0%)
Total	1/582 (0.2%)	3/329 (1%)	4/430 (1%)	3/310 (1%)	11/1599 (1%)

¹ Figures in the table are number of specimens with crushing/total number of specimens (percentage affected).

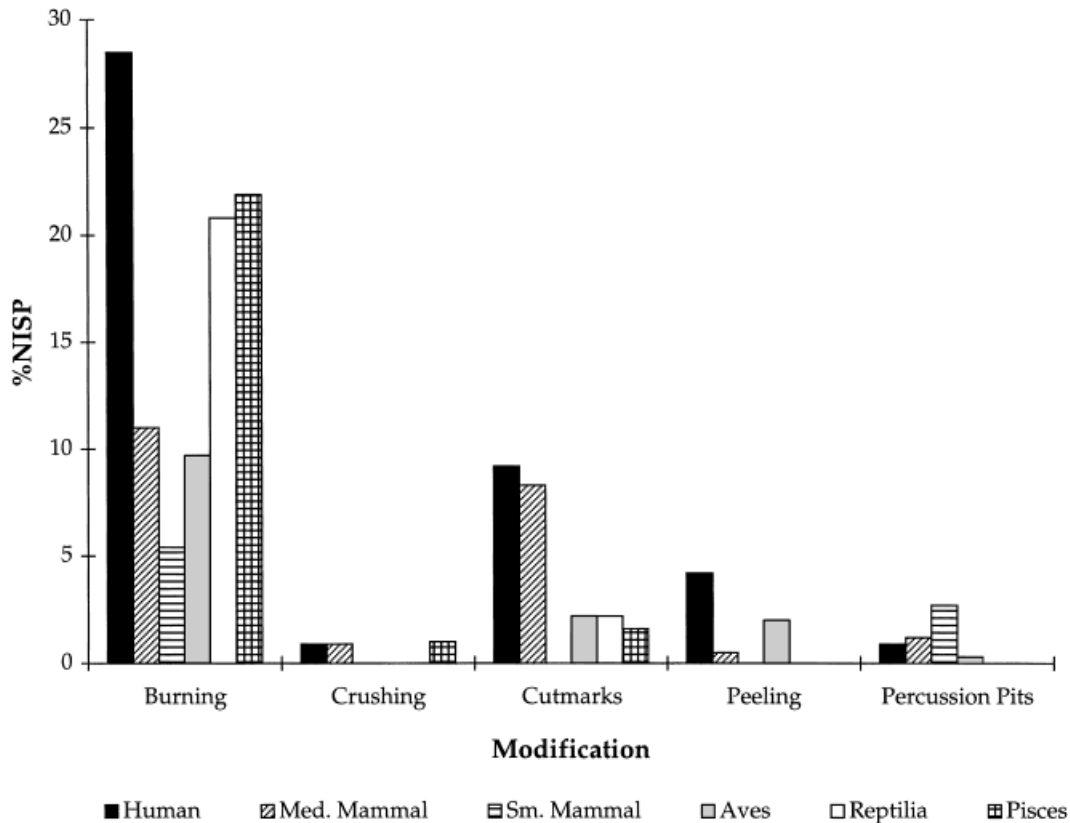


Fig. 10. Summary of modification frequencies in the Navatu midden sample. Bars represent the percentage of scorable specimens with a given modification.

wave-modified assemblage, while hands and feet are virtually absent (Spennemann, 1992). It is thus very unlikely that wave action modified the Navatu sample.

Carnivores (in the dietary rather than taxonomic sense) typically modify skeletal assemblages in two general ways: they alter

the element representation by preferentially accessing certain parts of the skeleton, and their chewing activity leaves bitemarks on bones (Lyman, 1994). The element representation in the midden human and burial samples does not resemble that of a representative canid-modified assemblage (Fig. 3).

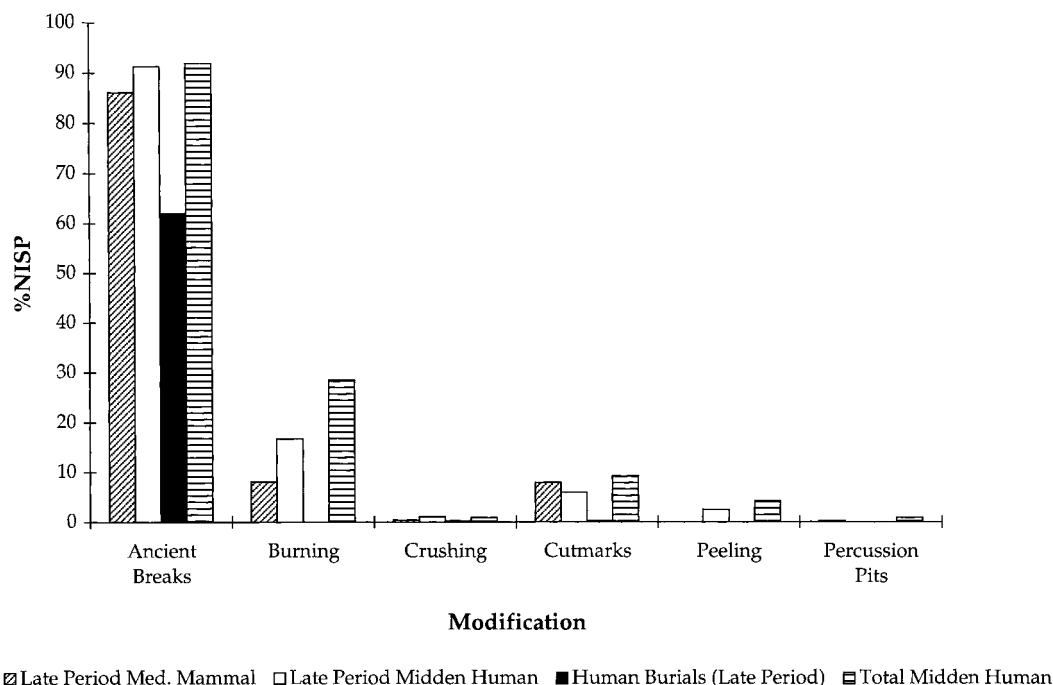


Fig. 11. Summary of modification frequencies in the Navatu midden and burial samples. Bars are as in Fig. 10.

Carnivores, and canids in particular, typically remove hands and feet (see figure one in Haglund et al., 1989) which are well-represented in the midden human sample. The low overall frequency of carnivore bitemarks in the midden sample, and their absence in the burials, provides further evidence that carnivores did not significantly modify this assemblage.

Large rodents such as porcupines can also alter the element representations of a skeletal assemblage. However, the only rodents known from Viti Levu are rats (*Rattus exulans* and *Rattus norvegicus*). Rats are unlikely to significantly alter the element distribution since they do not habitually accumulate bones (Hanney, 1975). The level of rodent damage to the Navatu assemblage can be judged by the frequency of rodent gnawing: 4% of the midden specimens show rodent gnawing, while none of the burial specimens do. Therefore, while rodents did modify the assemblage, their impact was limited to relatively few specimens. The large disparity in fragmentation between the midden and burial samples cannot be

explained solely by rodent activity. Even if the 11 bitemarks scored as of uncertain origin were all made by rodents, or all made by carnivores, neither group could be considered a major modifier of this assemblage.

Based on the above analysis, it appears that humans were the primary, though not exclusive, modifiers of the Navatu skeletal remains. The observed cutmarks, peeling, percussion pits, crushing, and burning can be attributed to the actions of prehistoric Fijians, who were probably responsible for a substantial portion of the fragmentation as well.

Comparison of Navatu with other Oceanic assemblages

Skeletal assemblages from four other sites in the Fijian archipelago have been interpreted as evidence of cannibalism: Lakeba (Best, 1985; Rowland and Best, 1980), Namosi (Spennemann, 1987), Vunda (Gifford, 1951), and Wakaya (Rechtman, 1992). The published data on bone modification in these samples are not sufficient to permit quantitative comparisons with the Navatu sample, but qualitative comparisons are possible.

The skeletal material from Lakeba (500 BC to AD 1900) contains both formal human burials as well as human and nonhuman bones in a midden context (Best, 1985). The human remains from the midden context are stated to be food remains based on "the small size of most fragments, charring on many of them, cut marks on some, and the under-representation of hands, feet and heads . . ." (Best, 1985, pp. 534, A84). No more detailed information is given regarding the modifications or element representation. The number of specimens (889) is provided only for the entire human sample, including burials. The Lakeba element representation is almost the inverse of that seen in the Navatu midden human sample. While an element representation significantly different from that normally seen in burials is indicative of alteration, human activity may not be the sole cause of the skewed representation (cf. Lyman, 1994). The fragmentation, burning, cutmarks, and midden context of the Lakeba human remains correspond at the grossest level with the pattern seen in the Navatu midden human remains. There is no mention of burning, cutmarks, or other such modifications in the formal human burials from Lakeba.

The Namosi (Viti Levu) sample consists of 13 human bone specimens from a minimum of four individuals embedded in a tree fork (Spennemann, 1987). The tree fork was collected in 1876, and Spennemann asserts that, "there is no question about . . . its being a cannibal relic" (Spennemann, 1987, p. 33). The specimens are relatively intact—roughly 50% to 80% complete — long bones (femur, humerus, tibia). Four specimens have cutmarks and one a chopmark. There is no mention of whether the bones are burned, but the photos suggest they are not. This sample differs in virtually all regards from the Navatu sample, so they likely represent the end products of different behaviors or processes. The modifications on the Namosi bones may have been the result of a noncannibalistic mortuary ritual (i.e., disarticulation of limbs prior to their placement in a tree), especially since similar cutmarks are found in formal burials on Wakaya (Rechtman, 1992).

The remains from the site of Vunda on Viti Levu were described along with those from Navatu by Gifford (1951). All remains from Vunda date to the Middle Period (AD 800–1100 to AD 1600–1800). The only information on bone modification provided by Gifford for either site is that the human remains were broken and some showed evidence of burning. A reanalysis of the Vunda skeletal sample is in progress (DeGusta, in press).

Rechtman (1992) recovered skeletal remains, including those of humans, from the sites of Korolevu and Delaini on the island of Wakaya. The sample dates from AD 1300 to AD 1825, and includes formal human burials and middens containing both human and nonhuman bones. Sample sizes are given only in terms of weight and density: 310.0 g of human bone was recovered from a midden context at Korolevu, 924.9 g from Delaini (Rechtman, 1992, p. 180). The modifications for which data are presented are the fracture angle (oblique, right, or oblique and right) and fracture outline (transverse, intermediate, or v-shaped and curved) of the human long bones from midden contexts (Rechtman, 1992, pp. 109–113). Only relative frequencies are reported, but oblique fracture angles and curved/v-shaped fracture outlines are most common. It is noted that cutmarks are rare on all bone ("a total of ten — five on human, four on pig and one on bird"), and that only a "very small percentage" of bone is burned (Rechtman, 1992, p. 109). Burning is also found on two virtually complete skeletons from the formal burials. Cutmarks are present on three relatively intact and complete skeletons (12 bones, mostly femora, tibia, and humeri) in the burials (Rechtman, 1992, pp. 160, 164, 169). The cutmarks on one individual are interpreted as consistent with the practice of torturing war captives (Rechtman, 1992, p. 163). The cutmarks on the other individuals are inferred to be related to positioning for burial (Rechtman, 1992, p. 169).

Based on the modifications and "refuse context" of the midden human remains, Rechtman (1992) states that they indicate cannibalism. It is not possible to independently evaluate that inference from the data presented. Fracture angle and outline data, in isolation, are not reliable indicators of the

agents that produced the observed patterns (White, 1992), especially for highly fragmented assemblages. The paucity of cutmarks and burning in the human midden remains, the presence of those modifications in the burial skeletons, and the lack of discussion of possible rodent and carnivore activity raise doubts about the interpretation of cannibalism.

As with Fiji, a number of skeletal assemblages in the greater Oceania region have been interpreted as indicating cannibalism, but no published reports were located that provided the quantitative data on bone modifications necessary for comparisons with the Navatu sample. (Given the vast literature on Oceanic archaeology, it is possible that such a report was overlooked.) However, work in progress on a skeletal sample from the Cook Islands may provide such data (P-K. Anderson and S.C. Antón, personal communication).

Comparison of Navatu with secondary burial and "massacre" assemblages

A number of assemblages have been interpreted to be the result of secondary burial processes, either following violence or as part of customary mortuary practices. Four such samples from different contexts were selected for comparison with the Navatu midden human remains. These comparisons are intended to be representative, rather than comprehensive, as it is impractical to compare the Navatu assemblage with every published skeletal assemblage.

The site of Juntunen is a Late Woodland (AD 1320) ossuary in Michigan that yielded 310 bones from at least 22 individuals (Russell, 1987 and references therein). A combination of archaeological, ethnographic, and historical evidence indicates that these individuals were buried, allowed to decompose, then exhumed, stripped of flesh, and reburied (Russell, 1987). There is no mention of burning in the Juntunen sample, and the description of the elements suggests that it is substantially less fragmentary than the Navatu midden sample. Cutmarks are present on 104 of the 310 human specimens (34%) at Juntunen (Russell, 1987). Russell (1987) interprets the relatively high frequency of cutmarks on the Juntunen sample

as characteristic of secondary burial with defleshing, and contrasts it to the reindeer butchery sample from Combe Grenal, which has cutmarks on only 8% of the reindeer specimens: "Cutmark frequency is relatively high when a cleaned bone is the goal of the defleshing and low when meat removal is the goal of the activity," (Russell, 1987, p. 391). The Navatu midden human sample is distinguished from the Juntunen secondary burials by its significantly lower frequency of cutmarks (9%, $p < 0.0001$), as well as the presence of burning and intensive fragmentation.

Monheimer and Skinner (1956) present a qualitative description of a possible Maori secondary burial from Otago, New Zealand (over 3,000 km from Viti Levu). The assemblage contains 65 human specimens, of which a number are relatively intact bones (e.g., a partial skull, three complete femora). The Otago sample, besides being less fragmentary than the Navatu midden sample, has a very different pattern of element representation: os coxae, femora, skulls, and teeth predominate, while there are no small bones (Monheimer and Skinner, 1956). There is also no mention of burning or cutmarks in the Otago sample.

Over 17,000 pieces of human bone from at least 486 individuals were recovered from the site of Crow Creek in south-central South Dakota (Willey, 1990). The assemblage dates to about AD 1325, and is interpreted as the result of a massacre. The Crow Creek assemblage apparently has more complete bones than does the Navatu midden human sample, with a number of articulated sets of remains being recovered (Willey, 1990, pp. 13–15). The patterns of element representation differ noticeably between the two samples: Crow Creek has proportionally far fewer hands and feet, and far more os coxae, mandibles, and sacrum (Willey, 1990, p. 21). The Crow Creek sample has a much higher percentage of cranial cutmarks (94% of frontals) than does the Navatu midden human sample (11% of frontals). The situation is the reverse for postcranial elements, as only 0.6% of the Crow Creek arm and leg specimens have cutmarks, while the frequency is 15% in the corresponding Navatu material. Burning is much rarer in the Crow Creek cranial assem-

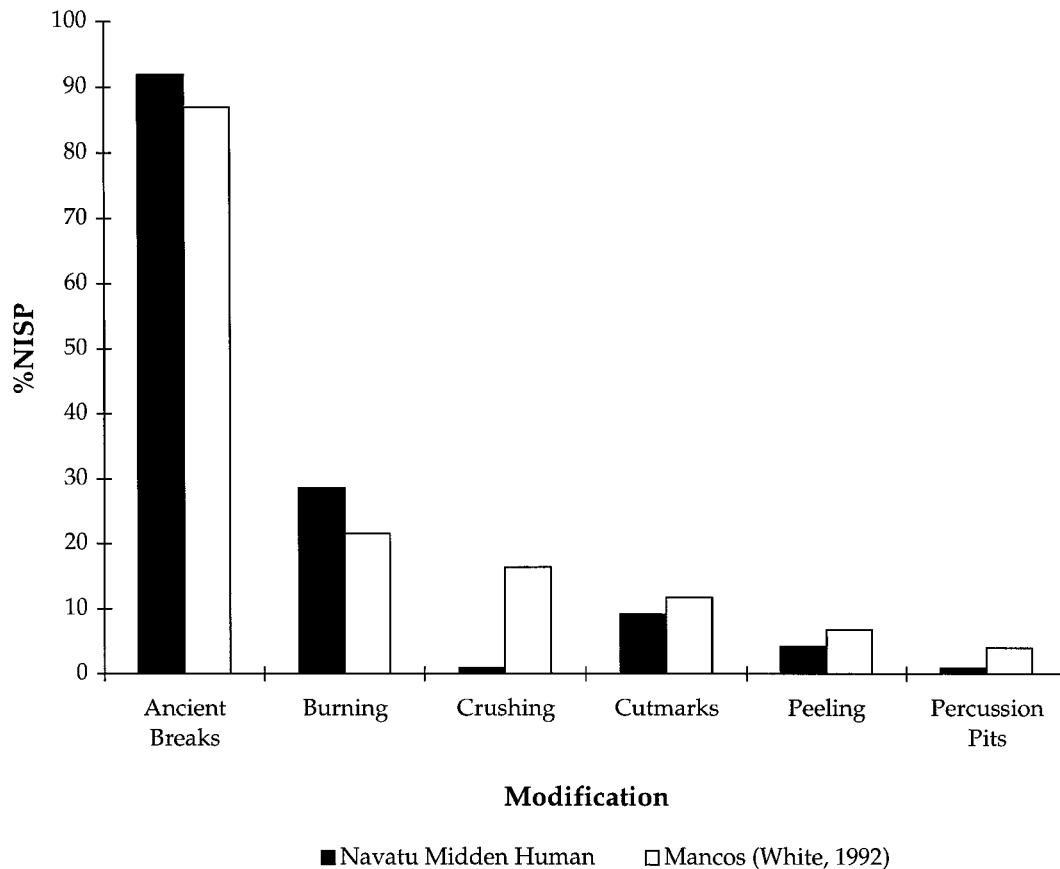


Fig. 12. Modification frequencies in the Navatu midden human sample compared to those of the Mancos 5MTUMR-2346 human sample (White, 1992). Bars are as in Fig. 10.

blage than in the Navatu midden human sample: seven Crow Creek skulls were charred out of at least 167 complete skulls (4%), while 41% of the skull specimens in the Navatu sample are burned.

The Larson Village site in north-central South Dakota yielded the remains of about 75 people and dates to about AD 1780 (Owsley et al., 1977 as cited in Willey, 1990). These remains are interpreted to be the result of warfare, as the individuals were probably killed in their lodges which were then set on fire (Owsley et al., 1977). The Larson Village sample has proportionally more os coxae, sterni, patellae, carpals, and tarsals than does the Navatu midden human sample. The Larson Village sample has a higher percentage of cranial cutmarks (38%) than does the Navatu midden human

sample (11%). Less than 2% of the Larson Village specimens are burned, while the frequency in the Navatu midden human sample is 29%.

Comparison of Navatu with American Southwest cannibalized assemblages

A large number of skeletal assemblages outside Oceania have been interpreted as indicative of cannibalism as reviewed by White (1992). The best-studied sites are from the American Southwest, where there are quantitative data available on the frequency of various bone modifications for a number of assemblages (Turner and Turner, 1999; White, 1992). Of these, two of the better-documented samples (Turner, 1993; White, 1992) were selected for comparison with the Navatu sample. It should be kept in

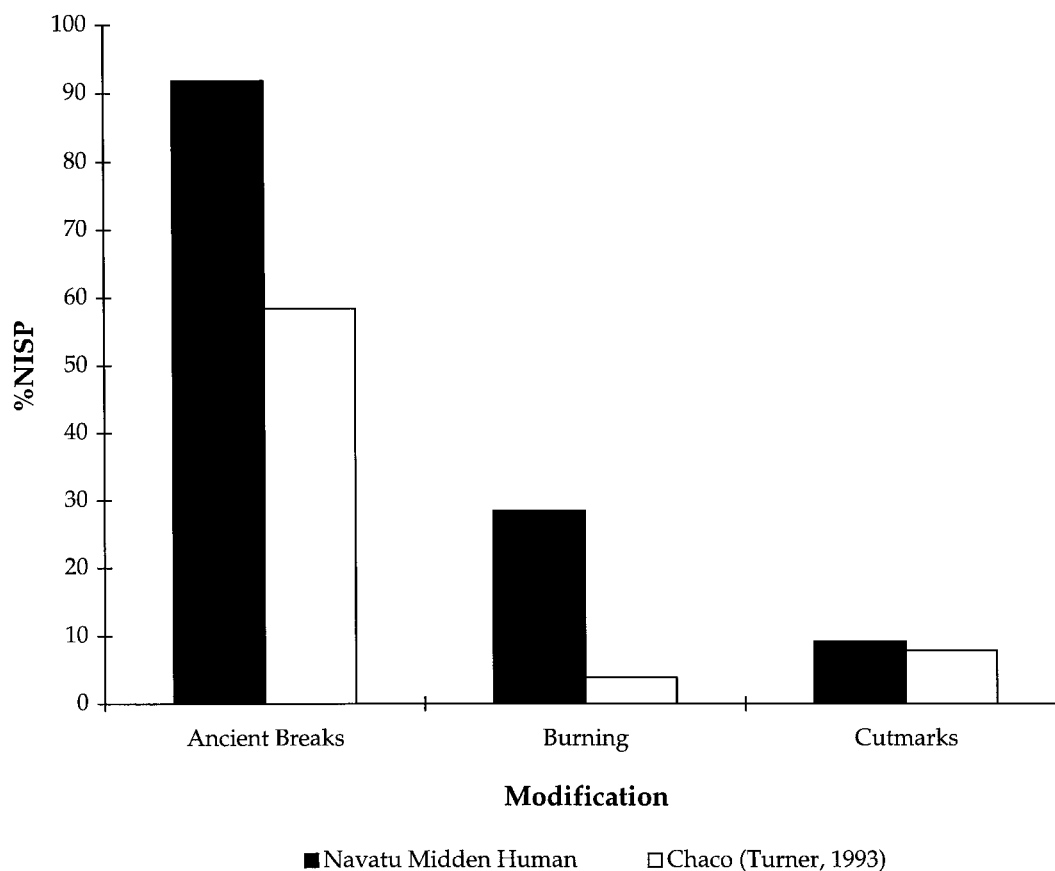


Fig. 13. Modification frequencies in the Navatu midden human sample compared to those of the Chaco Canyon human sample (Turner, 1993). Bars are as in Fig. 10.

mind, though, that there are considerable differences in modification frequencies between the various southwestern sites (see table one in Turner, 1993).

The site of Mancos 5MTUMR-2346 in southwestern Colorado yielded a large sample of human skeletal remains inferred to be evidence of cannibalism (Nickens, 1975). The extensive description and analysis of White (1992) provide ample support for that inference. The sample consists of 2,106 specimens of human bone (MNI = 29) recovered from several rooms of an Anasazi pueblo dwelling dating to about AD 1100 (White, 1992). Based on the context, conjoining, weathering, and bitemarking of the sample, it is likely that its modifications result from human behavior over a relatively short period of time (White, 1992, p. 83). The Navatu

sample, in contrast, spans almost 2,000 years. The Mancos specimens, while fragmented, are generally more complete than those from Navatu. The element representation of the Mancos sample (White, 1992, pp. 292–304) also differs from that of the Navatu sample — Navatu has a greater proportion of arm and hand specimens than does Mancos, but fewer mandibles, ribs, and lower legs. Methodologically, the data from Navatu and Mancos are readily comparable since the present study uses the methods and recognition criteria of White (1992), although not all modification types scored for the Mancos sample were examined in the Navatu assemblage.

The frequencies of various modifications in the Mancos sample and the Navatu midden human sample are compared in Figure

12. There are significant differences in the frequency of breakage, burning, crushing, and percussion pits. These differences may be a product of the disparities in context and sample composition noted above, or they may be due to differences in human behavior between prehistoric Fijians and Anasazi.

A charnel pit in Chaco Canyon, New Mexico yielded human bone inferred to represent the remains of cannibalistic activity (Turner, 1993). The 152 human bone specimens (MNI = 8) date to AD 900 and are assigned to the Anasazi culture (Turner, 1993). This assemblage seems likely to have been accumulated in a relatively short period of time, and the element representation is quite different from that of the Navatu midden human sample; Navatu has a higher proportion of hand specimens than does Chaco Canyon, but fewer mandibles, teeth, and feet. Figure 13 compares the frequency of the modification types scored for both the Chaco Canyon and Navatu assemblages. There are significant differences in the frequency of burning and breakage between the Chaco Canyon and Navatu samples, but Mancos and Chaco Canyon also differ significantly in this regard despite their geographic proximity and cultural similarity.

CONCLUSIONS

For an inference of cannibalism to be supported, the modifications of the human remains in question should correspond to modifications of nonhuman remains accepted as having been consumed (allowing for differences due to anatomy). The taphonomic history of the assemblage must be also assessed to identify nonhuman agents of modification, and an evaluation made of the possibility of noncannibalistic mortuary practices that might mimic cannibalism.

The assessment of the taphonomic history of the Navatu assemblage indicates that humans were the primary cause of the observed modifications, though some fragmentation may be due to other agencies. The modifications to the human remains in the Navatu midden generally correspond to those of the medium-sized mammals. There are no significant differences between the midden human and medium mammal remains in the frequencies of ancient breaks, shaft cir-

cumference preserved, tubular bone portion preserved, crushing, cutmarks, and percussion pits. Two modifications (burning and peeling) are significantly more common in the midden human remains than in those of other midden taxa. However, the frequencies of those modifications vary significantly between the various nonhuman taxa as well. Since there is little doubt that the fish, turtle, bird, and pig remains in the midden were consumed by humans, these differences in modification frequencies likely indicate differential processing due to anatomical or culinary considerations.

The human burials at Navatu provide direct evidence regarding mortuary practices at that time and place. The context and modifications of the Navatu burial remains are very different from that of the midden remains. Substantial variation has been documented in mortuary practices (e.g., Huntington and Metcalf, 1979), so this is not to say that a single set of burials accurately represents all Fijian mortuary rituals. Evidence from other Fijian sites (i.e., Wakaya) suggests that a few cutmarks may be expected in primary burials as a consequence of positioning, as well as rare instances of burning (Rechtman, 1992). However, the cutmarked and burned primary burial remains from Wakaya were virtually complete and intact skeletons not commingled with bones of other taxa, a very different circumstance from the Navatu midden human sample. Even if such primary burials were later disturbed and fragmented, the frequency of cutmarking and the patterning of burning would likely be quite different than that seen in the Navatu midden sample. Furthermore, other Fijian sites contain essentially unmodified formal burials similar to those at Navatu (Best, 1985; Gifford, 1951). Secondary tree fork burial results in a sample easily distinguishable from the Navatu assemblage based on context, element representation, and modifications (Spennemann, 1987). Thus, the available archaeological information on Fijian burial practices provides no evidence of noncannibalistic mortuary rituals that might produce remains with the butchering modifications seen at Navatu.

The context and modifications of the Navatu midden human sample are distinctly

different from secondary burial and violence-derived assemblages. Secondary burial with defleshing (Juntunen; Russell, 1987) appears to result in less fragmentary remains with a higher percentage of cutmarks on all elements but no burning. Secondary burial without defleshing (Otago; Monheimer and Skinner, 1956) appears to result in less fragmentary remains, a different pattern of element representation, and no cutmarks or burning. Secondary burial following violent death (Crow Creek; Willey, 1990) results in less fragmentary remains, a different pattern of element representation, far more cranial cutmarks, far fewer postcranial cutmarks, and much less burning. Violent death followed by deposition in burned dwellings (Larson Village; Owsley et al., 1977) results in a different pattern of element representation, significantly more cranial cutmarks, and much less burning. The many significant differences between these assemblages and the Navatu midden human sample indicates that secondary burial and/or noncannibalistic violence are not responsible for the condition of the Navatu remains.

The analysis of the Navatu skeletal material supports the hypothesis that the human bones in the midden are the remains of cannibalized individuals. The modifications on the midden human remains generally correspond with those of the other taxa; a consideration of taphonomic factors indicates that humans are the primary modifiers of the assemblage; and the modifications and context of the Navatu midden human sample are distinctly different from those found in Fijian formal burials and in a variety of secondary burials (including those derived from violence).

In order to provide a truly independent test of the ethnohistorically generated hypothesis of Fijian cannibalism, the preceding osteological evaluation does not utilize ethnohistorical accounts. In the final analysis, though, it should be considered that Fiji has one of the strongest historical records of cannibalism — there are over 20 independent, firsthand historical accounts of Fijian cannibalism from the first half of the 19th century (Rechtman, 1992, pp. 102–108). It is imperative to assess the reliability of these accounts before accepting them as accurate

depictions of historic Fijian activities (cf. Arens, 1979), but such a “filtering” analysis is beyond the scope of the present work.

It is also tempting to attempt to match the pattern of osteological damage documented in this study with historical descriptions of cannibalism in Fiji. However, these accounts describe such a wide variety of different butchery and consumption practices that virtually any osteological patterning found (including that of the present study) could be accommodated by the Fijian historical record. The same appears to be true, though perhaps to a lesser extent, for noncannibalistic Fijian mortuary rituals. This renders meaningless any matches between the archaeological record and the “unfiltered” ethnohistory.

Critics have reacted to bioarchaeological analyses of cannibalism by claiming that such analysis is “mere inference” (Bahn, 1992b), that archaeological evidence is always ambiguous (Bahn, 1992b), and that it is impossible to prove cannibalism happened (Arens quoted in Osborne, 1997). It is not possible to *absolutely prove* anything about past human dietary behavior (cf. Lyman, 1982). It is possible (though extremely unlikely) that the fish, bird, turtle, pig, and human remains found in the Navatu midden were not consumed by Fijians, but instead were butchered, cooked, and discarded without being eaten. However, every line of evidence that supports the inference that the nonhuman taxa were consumed also supports the inference that the humans were consumed. In this case, then, the choice is to accept an inference of cannibalism or conclude that nothing can be known about prehistoric diet.

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